þÿ T r a j e c t o r i e s o f m o t h e r s a n d f a t h e r s d e p r e s s i v e from pregnancy to 24 months postpartum

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2020-01-01

Kiviruusu , O H , Pietikäinen , J T , Kylliäinen , A , Pölkki , P , Saarenpää-Heikkilä , O , þÿ M a r t t u n e n , M , P a u n i o , T & P a a v o n e n , E J 2020 , ' T r a j e c t o r i e s o f m depressive symptoms from pregnancy to 24 months postpartum ' , Journal of Affective Disorders , vol. 260 , pp. 629-637 . https://doi.org/10.1016/j.jad.2019.09.038

http://hdl.handle.net/10138/306825
https://doi.org/10.1016/j.jad.2019.09.038

Journal of Affective Disorders 260 (2020) 629–637

Contents lists available at ScienceDirect

Journal of Affective Disorders

journal homepage: www.elsevier.com/locate/jad

Research paper

Trajectories of mothers' and fathers' depressive symptoms from pregnancy to 24 months postpartum

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ARTICLE INFO

Keywords:
Perinatal depression
Postpartum depression
Maternal depression
Paternal depression
Depression trajectories

ABSTRACT

Objectives: This study investigated trajectories of mothers' and fathers' depressive symptoms from prenatal to 24 months postpartum. Prenatal correlates of the trajectories were also examined.
Methods: Mothers ($N = 1670$) and fathers ($N = 1604$) from the Finnish CHILD-SLEEP birth cohort, reported depressive symptoms at 32nd pregnancy week and 3, 8, and 24 months postpartum using the Center for Epidemiologic Studies Depression Scale (CES-D, 10-item). Profile analysis was used to group participants according to their longitudinal patterns of depressive symptoms. Prenatal predictors (sociodemographic, health, substance use, sleep, and stress related factors, family atmosphere) of depressive symptom trajectories as well as association between parents' trajectories were analyzed using multinomial logistic regression.
Results: For both mothers and fathers, a solution with three stable depressive symptom trajectories (low: 63.1% mothers and 74.9% fathers; moderate: 28.1% and 22.6%; high: 8.8% and 2.6%) was considered the best fitting and most informative. Insomnia, earlier depression, anxiousness, stressfulness, and poor family atmosphere predicted the moderate and high (compared to low) depressive symptom trajectories among both mothers and fathers in multivariate analyses. Mother's higher depressive symptom trajectory was significantly associated with father's higher symptom trajectory ($p < 0.001$).
Limitations: Number of cases in the high depressive symptom trajectory group among fathers was low.
Conclusions: Maternal and paternal depressive symptom trajectories from prenatal period up to two years postpartum seem stable, indicating the chronic nature of perinatal depressive symptoms. Mothers' and fathers' trajectories are associated with each other and their strongest predictors are common to both.

1. Introduction

Perinatal depression affects up to 19% of mothers at some point during pregnancy or postpartum (Gavin et al., 2005; O'Hara and McCabe, 2013), while approximately 8% of fathers suffer from depression between the first trimester of pregnancy and one-year postpartum (Cameron et al., 2016). In recent years, parental depression trajectories from the prenatal period to the first few years postpartum have also gained more research interest, shedding light on the heterogeneity in the longitudinal course of perinatal depression (Santos et al., 2017). While there have been many trajectory studies on mothers' depression or depressive symptoms, fathers' depression trajectories have been studied less. However, entrance to fatherhood seems to be associated with an increase in depressive symptoms (Garfield et al., 2014; Cameron et al., 2016) and the importance of expecting and new fathers' mental well-being on child's mental health has been recognized (Paulson et al., 2006; Sweeney and MacBeth, 2016), also independently from mothers' well-being

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https://doi.org/10.1016/j.jad.2019.09.038
Received 31 March 2019; Received in revised form 21 August 2019; Accepted 8 September 2019
Available online 10 September 2019

(Ramchandani et al., 2008). The importance of fathers's as well as mother's psychological well-being has also recently been highlighted in the NHS new policy on offering fathers mental health assessment and support if the mother suffers from a psychiatric disorder (NHS, 2019).

In their systematic review of 22 studies on maternal depression trajectories, Santos et al. (2017) found studies to report two to six distinct trajectories, most commonly three (eight studies). While many studies reported at least one time-varying trajectory, in most of them the majority of trajectories were stable, and all studies reported a stable low/no depression (usually the largest) trajectory group and a stable high (usually the smallest) group with chronic, clinically significant levels of symptoms (Santos et al., 2017). These two latent trajectory groups were also found by Drozd et al. (2018), with 91% of mothers in the low depression trajectory group and 9% in the high depression trajectory group, although both trajectories indicated a slight trend of decreasing depressive symptoms. Further, in a systematic review of studies using growth curve mixture modeling on mothers' perinatal depressive symptoms, the results were very similar: a stable low trajectory was reported in all included 11 studies and a stable moderate-high or high symptom trajectory throughout the perinatal period was reported in eight of 11 studies, while six studies also reported transient trajectories (Baron et al., 2017).

There are only very few studies on fathers' depressive symptom trajectories during the perinatal or postpartum period. Among 126 first-time Italian fathers, three depression trajectory groups were found, representing stable low (52%), stable moderate (37%), and emergent clinical (11%) depression trajectories from the third trimester of pregnancy to one year postpartum (Molgora et al., 2017), suggesting quite similar depression trajectory patterns among fathers compared to those among mothers reviewed above. However, a recent Finnish study among normative and former infertile couples ($N = 773$) found eight paternal mental health trajectories of which only one was labeled as stable, although this low depressiveness group then comprised a large majority (79%) of the fathers (Vänskä et al., 2017).

Previous research has indicated several risk factors for maternal perinatal and postpartum depression. Of these, the most consistently reported include a history of mental disorder (mood disorder, anxiety, substance use), prenatal depression and anxiety, stressful life events, complications during pregnancy, multiparity, mothers' younger age, low income, low education, lack of social support, and marital dissatisfaction (e.g., Beck, 2001; Davé et al., 2010; Vliegen et al., 2014; Postpartum Depression: Action Towards and Treatment Consortium, 2015; Tebeka et al., 2016; Fiala et al., 2017). Also, in their reviews of maternal depressive symptom trajectories, Santos et al. (2017) and Baron et al. (2017) found very similar risk factors (e.g., low education, stress, depressive or anxiety symptoms during pregnancy, history of psychopathology, younger maternal age, and sleep difficulties) of the higher symptom trajectories. However, Baron et al. (2017) concluded in their review that none of the investigated characteristics (demographic, personality, or clinical factors) were able to systematically differentiate women assigned to different symptom trajectories, within or across studies.

Fathers' risk factors for perinatal and postpartum depression seem to be the same as those found among mothers. Davé et al. (2010), for example, found a history of depression, younger age, and higher social deprivation to be associated with a higher incidence of parental depression among both mothers and fathers. Leung et al. (2017) studied partnered mothers and fathers and found low household income, high prenatal depressive symptoms, and low social support postnatally to be predictors of postpartum depression for both mothers and fathers, while stressful life events and smoking were also significant risk factors among fathers. Saxbe et al. (2016) found problems in sleep quality to predict persistence of both mothers' and fathers' postpartum depressive symptoms. Their results also indicated that mothers' sleep problems were associated with fathers' later depressive symptoms, suggesting difficulties in sleep to be a possible mechanism in the transmission of depression from mothers to fathers (Saxbe et al., 2016). Indeed, having a partner with elevated depressive symptoms or depression has been indicated as the most common correlate of paternal depressive symptoms pre- and post-birth (Wee et al., 2011); and according to a meta-analysis of 43 studies, paternal depression is moderately correlated ($r = 0.31$) with maternal depression (Paulson and Bazemore, 2010). Further, using a latent class growth analysis on mothers' and fathers' depressive symptoms from pre-birth to 12 months postpartum, Volling et al. (2018) found 9.5% of families to belong to a class where both parents had high depressive symptoms.

Parents' perinatal depressiveness is an important field of research, not only due the sufferings of the parents themselves, but especially due to the harmful short and long-term psychosocial consequences on the newborn baby (Fiala et al., 2017; Meaney, 2018). More research on fathers' depression has been called for (e.g., Wee et al., 2011), while studies on fathers' depressive symptom trajectories during the perinatal period are very scarce to date. Given the scarce evidence on fathers' depressive symptoms, the present study will examine both mothers' and fathers' depressive symptom trajectories from prenatal to 24 months postpartum in a Finnish community sample. We also study whether parents' prenatal sociodemographic, health (including psychological), substance use, sleep, and stress related factors and family atmosphere are correlated with their depressive symptom trajectories. Furthermore, the association between mothers' and fathers' depressive symptom trajectories is examined.

Based on earlier research among mothers we expect to find relatively small number of trajectories with the majority of them characterized by stability of symptom levels. Among fathers, however, the existing research is too scarce to state strong expectations. We expect previous or prenatal psychopathology, life stress, and problems relating to social relationships in the family to be among the strongest risk factors for the higher depressive symptom trajectories. We also expect that parental depressive symptom trajectories are associated with each other.

2. Methods

The present study is part of the CHILD-SLEEP cohort, a population-based longitudinal birth cohort study from Pirkanmaa in southern Finland. The study protocol has been reviewed by the Pirkanmaa Hospital District (PHD) Ethics Committee (9.3.2011, code R11032), and a written informed consent has been obtained from all participants. The study design, protocols, and measures have been described in more detail in Paavonen et al. (2017).

3. Subjects

Families were recruited to the study during their normal follow-up visits to the maternity clinics in the PHD catchment area between April 2011 and December 2012. Eligible participants were those Finnish-speaking families whose infants were born alive in the Tampere university hospital (the main maternity hospital in the catchment area). The sampling unit was a family, i.e. mothers and fathers were recruited together. Single mothers were able to participate, but almost all (97.8%) participating mothers lived in a two-adult household. During the recruitment visit, the consenting parents were given the first set of questionnaires to be later returned.

Both parents were evaluated at gestational week 32 and 3, 8 and 24 months postpartum using self-report questionnaires. The final sample was 1677 families (1677 mothers; 1622 fathers) comprising all those for whom there was at least one parental questionnaire available from the four possible measurement points. There were 1667 mothers (99.4%) and 1598 fathers (98.5%) at 32nd gestational week, 1421 mothers (84.7%) and 1343 fathers (82.8%) at 3 months, 1299 mothers (77.5%) and 1211 fathers (74.7%) at 8 months and 1038 mothers (61.9%) and 776 fathers (47.8%) at 24 months postpartum

participating in the study.

4. Measures

4.1. Outcomes

Mothers' and fathers' depressive symptoms were measured prenatally and at the child's age of 3, 8, and 24 months using the 10-item version of the Center for Epidemiological Studies Depression Scale, CES-D (Radloff, 1977; Irwin et al., 1999). Items, rated on a four-point Likert-type scale, were summarized, a higher score indicating more severe depressive symptoms (scale range 0–30 points). Two of the items were reversed before computing the scale and a maximum of 3 missing items (replaced by the individual's mean) were allowed. CES-D was used as a continuous measure in the analysis, while prevalences of "self-reported depression" are also reported using a cut-off score ≥10, which has been indicated to provide acceptable sensitivity and specificity against the criterion of caseness for clinically significant depression set by the original 20-item CES-D (Grzywacz et al., 2006).

4.2. Prenatal predictors

Prenatal predictor variables were derived from questionnaires filled separately by the mother and father at gestational week 32. Sociodemographic variables included age, any previous children (yes/no), education, and personal income. A three-category variable was construed for education: (1) "none or some vocational training", (2) "vocational degree or polytechnic", and (3) "university". A low-income variable was coded "yes" if personal net income was below 1000 euros per month and otherwise "no".

For mothers, a variable of smoking was coded to indicate whether the mother had smoked at least once during the past six months (yes/no); for fathers, the variable indicated current smoking (yes/no). A dichotomized (yes/no) variable on frequency of alcohol consumption was computed to indicate among mothers consumption at least monthly during pregnancy and among fathers consumption at least 2 times a week.

Two variables relating to parents' sleep problems were formulated (insomnia and sleepiness). Insomnia was measured with five items (difficulties to fall asleep, night awakenings per week, average number of awakenings per night, too early awakenings, and poor sleep quality) from the Basic Nordic Sleep questionnaire (BNSQ) (Partinen and Gislason, 1995), first coded for clinical significance (yes/no) and then summarized (range 0–5). A cut-off of two or more was used to indicate multiple insomnia-related difficulties (yes/no). Sleepiness was measured with the Epworth Sleepiness Scale (ESS) (Johns, 1991), consisting of eight questions rated on a four-point scale (0–3). The sum-score (range 0–24) was dichotomized at 11 points as defined previously to represent deviant daytime sleepiness.

Health variables included any pregnancy related health problems (e.g., gestational diabetes, back problems, nausea) (yes/no), somatic illness/disability (yes/no), diagnosed depression (lifetime; yes/no), use of antidepressant medication during past six months (yes/no), and anxiousness. Anxiousness was measured using a six-item anxiety questionnaire derived from the STAI trait anxiety scale. These six items have been shown to load on the "anxiety" factor of the STAI trait scale and to have convergent and discriminant validity (Bieling et al., 1998). The items on a four-point scale were summarized (range 4–24) and a dichotomized variable using a cut-off 12 or more (90th percentile) was used to indicate increased levels of anxiousness.

Stressfulness was measured with five items on a five-point scale derived from the Perceived Stress Scale (Cohen et al., 1983) tapping how unpredictable, uncontrollable, and overloaded the respondents find their lives. The summary score (range 0–20) was dichotomized at 10 (90th percentile) points to represent elevated levels of stressfulness. Adverse life events were measured using a list of 11 potentially distressing life events (e.g., death of a relative, substantial financial crisis) (Brugha and Cragg, 1990), and a dichotomized variable "two or more distressing events" was calculated for the analyses.

We used a measure of family atmosphere to assess quality of social relationships in the family and as a proxy for marital dissatisfaction. Family atmosphere was evaluated using seven items rated on a seven-point semantic differential scale (e.g., approving (=1) – disapproving (=7); safe (=1) – unsafe (=7); quarrelsome (=1) – harmonious (=7)). All the seven items have been shown to load on one factor indicating one-dimensionality of the measure (see Paavonen et al., 2017). Three of the items were reverse-coded and a summary score was calculated (range 7–49) with lower values indicating poorer family atmosphere. The summary score was dichotomized at 35 points (10th percentile) to indicate poor family atmosphere.

5. Statistical analyses

Analyses were made using IBM SPSS Statistics 25 unless stated otherwise. Separate analyses were made for mothers and fathers.

To explore different longitudinal profiles or change trajectories of parental depressive symptoms, a latent profile analysis (LPA) (Gibson, 1959) was applied for CES-D scores from the questionnaire data using Mplus 7.1 software (Muthén and Muthén, 1998–2012). LPA is a finite mixture model method used to identify homogenous unobserved groups or profiles based on observed variables. It can be applied to longitudinal data, while it takes no a priori assumptions on the general pattern or functional form of the change. The statistical criteria used to determine the best solution (number of profiles/trajectories) were the Bayesian Information Criteria (BIC), Sample-size Adjusted BIC (A-BIC), Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMR), Lo-Mendell-Rubin Adjusted likelihood ratio test (LMR-A), Bootstrapped likelihood ratio test (BLRT), and entropy. To decide the optimal group solution, an emphasis was also placed on large enough group sizes and clinically relevant and informative interpretation (e.g., Lennon et al., 2018). After determining the best solution, cases were assigned to the latent profile groups according to their most likely profile group membership. An inclusion criterion for the LPA of depressive symptoms was having at least one valid CES-D score from the four assessment points, leaving 1670 mothers and 1604 fathers for the profile analyses. Missing values due to attrition were handled by the Full Information Maximum Likelihood (FIML) estimation method, which produces less biased results than conventional methods of dealing with missing data, such as listwise deletion (Allison, 2003).

Multinomial logistic regression analyses were then used to assess whether the baseline (prenatal) characteristics of parents predict depressive symptom trajectory memberships. Univariate analyses were done first with one predictor variable at a time in the model. Then, to find out which predictors have the strongest effects (i.e. in the presence of other predictors in the model) on the trajectories, multivariate analyses were performed using the backward stepwise selection method, which begins with all predictors in the initial (full) model and then eliminates variables in successive steps until no variables can be removed without a statistically significant loss of model fit. The association between mothers' and fathers' depressive symptom trajectories was analyzed with cross-tabulation and chi-square test. In the analyses, p-values <0.05 were considered statistically significant. For relative risk ratios (RRR), 95% confidence intervals (CI) were calculated.

6. Results

Descriptive statistics of the study variables at baseline are given in Table 1.

Means of mothers' CES-D scores showed a slight decrease from gestational week 32 to 3 months postpartum; but after that, the scores increased and were above the prenatal level, both at 8 and 24 months postpartum (Table 2, Supplement Fig. 1). Among fathers, the mean

Table 1
Means (SD) and frequencies of the study variables at baseline.

Variable	Mothers (N = 1670)		Fathers (N = 1604)	
	N[c]	Mean (SD) /%	N[c]	Mean (SD) /%
Age	1626	30.7 (4.6)	1436	32.5 (5.3)
Having previous child/children	1527	52.7%	1386	54.4%
Education	1607		1531	
None or some vocational training		7.3%		11.0%
Vocational degree or polytechnic		58.4%		59.3%
University		34.2%		29.7%
Low personal net income	1609	23.1%	1543	6.9%
Smoking during pregnancy/ currently[a]	1640	5.8%	1555	18.1%
Alcohol use, monthly/two times a week[b]	1626	12.5%	1559	28.9%
Insomnia (BNSQ ≥ 2)	1635	50.8%	1536	10.5%
Sleepiness (ESS ≥ 11)	1645	4.7%	1561	4.4%
Pregnancy related health problems	1594	25.2%	–	–
Somatic illness/disability	1635	22.1%	1537	16.5%
Diagnosed depression, lifetime	1473	14.3%	1348	7.1%
Using antidepressants, past six months	1635	3.2%	1557	4.6%
Anxiousness (STAI ≥ 12)	1643	13.6%	1560	11.0%
Stressfulness (PSS ≥ 10)	1644	9.4%	1560	7.6%
Two or more distressing life events	1636	13.3%	1551	11.3%
Poor family atmosphere	1639	10.1%	1545	10.5%

BNSQ = Basic Nordic Sleep Questionnaire (five items); ESS = Epworth Sleepiness Scale; STAI = State-Trait Anxiety Inventory (six items); PSS = Perceived Stress Scale (five items).

[a] For mothers: having smoked at least once during the past six months.

[b] For mothers: at least monthly during pregnancy; for fathers: at least 2 times a week.

[c] Ns refer to available data for the measure in question.

Table 2
Means (SD) of depressive symptoms (CES-D) and frequencies of self-reported depression (CES-D ≥ 10) at baseline and follow-ups.

Variable	Mothers (N = 1670)		Fathers (N = 1604)	
	N[a]	Mean (SD) /%	N[a]	Mean (SD) /%
Depressive symptoms				
CES-D sum, 32nd gestational week	1640	5.11 (3.50)	1557	3.76 (3.14)
CES-D sum, 3 months	1415	4.63 (3.78)	1316	3.75 (3.23)
CES-D sum, 8 months	1291	5.47 (4.08)	1196	4.10 (3.56)
CES-D sum, 24 months	1038	5.51 (3.96)	774	4.73 (3.48)
Self-reported depression				
CES-D ≥ 10, 32nd gestational week	1640	11.0%	1557	5.1%
CES-D ≥ 10, 3 months	1415	10.5%	1316	5.2%
CES-D ≥ 10, 8 months	1291	14.7%	1196	6.9%
CES-D ≥ 10, 24 months	1038	14.5%	774	10.2%

[a] Ns refer to available data for the measure in question.

level of depressive symptoms also increased after the 3-month postpartum assessment. The prevalence of self-reported depression (CES-D ≥ 10) among mothers at prenatal was 11.0% and it increased to 14.5% at 24 months postpartum, while among fathers the prevalence doubled from 5.1% (prenatal) to 10.2% (24 months).

To identify longitudinal latent profiles of parents' CES-D symptoms from 32nd gestational week to 24 months postpartum, latent profile analyses were run separately for mothers and fathers. Among mothers, changes in the information criteria based statistics (BIC, A-BIC) were relatively large until the five-profile solution (Supplement Table 1). The VLMR and LMR-A statistics favored the four-group solution, while entropy (0.761) was better in the three-group solution. As the four-group solution was considered not to add clinically relevant information to the phenomenon (four, instead of three, profiles constantly at different levels), the three-group solution was considered most informative and with an acceptable fit to the data. Among fathers, the VLMR and LMR-A statistics favored the three-profile solution. As also the entropy was good (0.866), the three-group solution was considered best fitting the data.

The three-profile solutions consisted of relatively stable profiles which were quite similar among mothers and fathers (Fig. 1). The largest profile was the "low" trajectory group (63.1% among mothers and 74.9% among fathers), constantly reporting (on average) mild depressive symptoms (mean CES-D < 4). The second largest group was the "moderate" trajectory (28.1% and 22.6%) with stable moderate or subthreshold depressive symptoms (mean CES-D above 6 and below 9 points). The "high" profile (8.8% and 2.6%) reported (on average) constantly depressive symptoms above the clinical threshold (CES-D > 10). Among fathers, the "high" profile had a moderate peak at 8 months postpartum. The number of cases in the "high" profile among fathers was relatively small (41) compared to the "high" profile of mothers (N = 147). The observed means and lower and upper quartiles of CES-D scores for each measurement point by the trajectory group are given in Supplement Table 2.

Among mothers, prenatal factors (measured at 32nd gestational week) that were associated with an increased risk of belonging to the "moderate" and "high" depressive symptom trajectory groups (relative to the base category of "low" trajectory) in univariate analyses were low personal net income, insomnia, sleepiness, pregnancy-related health problems, lifetime diagnosed depression, use of antidepressant drugs, anxiousness, stressfulness, distressing life events, and poor family atmosphere (Table 3). Membership in the "high" trajectory was also predicted by having previous children, smoking during pregnancy and having a somatic illness or disability, while having a university degree reduced the relative risk of belonging to the "high" depressive symptom profile. In multivariate analyses, the significant predictors of both "moderate" and "high" (relative to the "low") trajectory memberships were poor family atmosphere, stressfulness, and anxiousness, in addition to insomnia and diagnosed depression (Table 3).

In univariate analyses among fathers, prenatal factors that were associated with an increased risk of belonging to the "moderate" and "high" depressive symptom trajectory groups (relative to the "low" trajectory group as a base category) were low personal net income, insomnia, somatic illness/disability, lifetime diagnosed depression, use of antidepressant drugs, anxiousness, stressfulness, distressing life events, and poor family atmosphere (Table 4). Membership in the "high" trajectory was also predicted by current smoking, while having a university degree reduced the relative risk of belonging to this trajectory. In addition, sleepiness predicted membership in the "moderate" trajectory group. Like in mothers, insomnia, diagnosed depression, anxiousness, stressfulness, and poor family atmosphere were significant predictors of both "moderate" and "high" (relative to the "low") trajectory memberships in multivariate analyses among fathers (Table 4). The "moderate" trajectory was also predicted by distressing life events in multivariate analyses.

Cross-tabulation of maternal and paternal depressive symptom trajectory groups (Table 5) revealed that the two trajectory groupings were highly associated with each other (X^2 = 104.6, df = 4, $p < 0.001$). For example, 82.1% of children with a mother in the "low" maternal depressive symptom trajectory group had a father in the "low" paternal depressive symptom group and 1.1% in the "high" paternal depressive symptom group, while the corresponding figures for a child with a mother in the "high" depressive symptom trajectory were 48.9% and 9.0% for the "low" and "high" paternal depressive symptom trajectories, respectively.

7. Discussion

The present study investigated parental trajectories of depressive

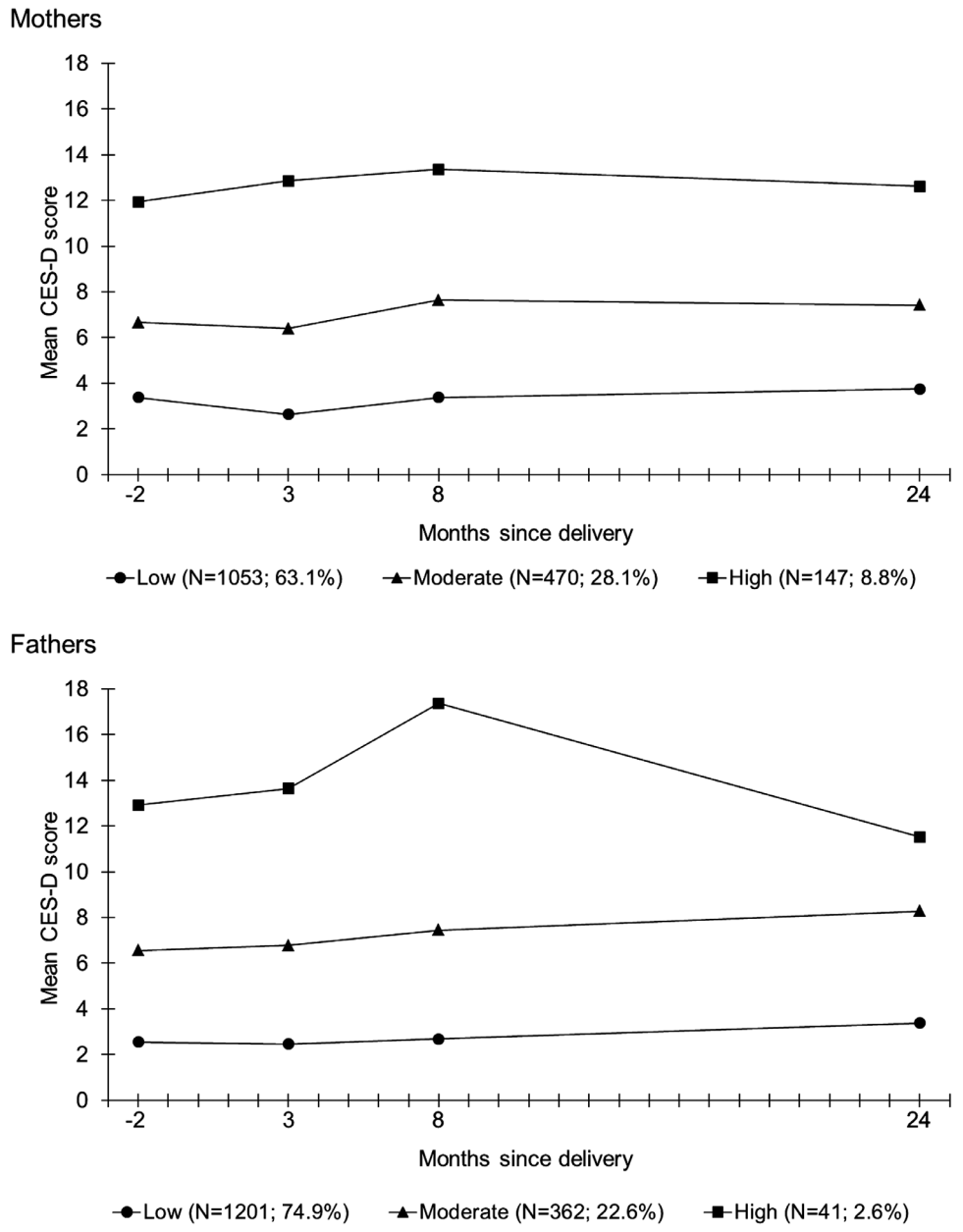

Fig. 1. Three profile solutions from lungitudinal latent profile analyses of depressive symptoms among mothers and fathers.

symptoms from pregnancy to two years postpartum. Among both mothers and fathers, we found three relatively stable depressive symptom trajectories, which were also considered clinically relevant. Insomnia, lifetime diagnosed depression, anxiousness, perceived stress, and poor family atmosphere were the strongest prenatal predictors of the higher depressive symptom trajectories; and these predictors were common to both mothers and fathers alike. Further, parental depressive symptom trajectories were correlated, suggesting that a higher depressive symptom trajectory in one parent is a risk factor for the other parent to have a higher trajectory as well.

Our finding of three stable perinatal trajectories of depressive symptoms is well in line with our expectations based on previous research on maternal depression trajectories. For example, in their review, Santos et al. (2017) summarized studies to provide collective evidence for at least three heterogeneous trajectory patterns of perinatal depression among mothers with low, medium, and chronic-high symptom levels. While the exact number of depression trajectories likely depends on sample characteristics, methodologies used, and applied statistical criteria, stability seems to be one frequently reported characteristic of these trajectories (Baron et al., 2017; Santos et al., 2017). For those depressed, stability of trajectories means chronicity. Previous research has indicated that while the majority of women recover from postpartum depression, there is a relatively large subgroup of women among whom it becomes chronic (Vliegen et al., 2014). In our study, 8% of mothers were classified as having constantly high, clinically significant levels of depressive symptoms, and 28% of mothers were classified as having persistent moderate or subthreshold levels of symptoms. Recent studies also suggest that these subclinical perinatal symptom levels are to be considered problematic, with consequences on the mother's and offspring's health and psychosocial well-being on an equal plane as the more severe levels of perinatal depressiveness (Meaney, 2018). In addition, it has been discussed that these stable subclinical symptoms should be viewed as a chronic type of perinatal depression (Vliegen et al., 2014). Nevertheless, our findings suggest that perinatal depression, whether mild or more severe, begins in many cases already during pregnancy, thus indicating a phenomenon

Table 3
Baseline predictors of maternal depressive symptom trajectories. Relative risk ratios (RRR) from multinomial logistic regression models.

	Moderate depressive symptom trajectory (N = 470)[a]						High depressive symptom trajectory (N = 147)[a]					
	Univariate			Multivariate[b]			Univariate			Multivariate[b]		
Predictor variable	RRR	(95% CI)	p	RRR	(95% CI)	p	RRR	(95% CI)	p	RRR	(95% CI)	p
Age	0.98	(0.96–1.01)	0.115				0.98	(0.94–1.02)	0.221			
Having previous child/children	1.01	(0.81–1.27)	0.921				2.10	(1.41–3.13)	<0.001			
Education			0.591						0.033			
None or some vocational training	1.00						1.00					
Vocational degree or polytechnic	0.80	(0.52–1.23)	0.306				0.59	(0.33–1.07)	0.080			
University	0.82	(0.52–1.28)	0.373				0.43	(0.23–0.82)	0.010			
Low personal net income	1.57	(1.21–2.03)	0.001				2.73	(1.87–3.98)	<0.001			
Smoking during pregnancy	1.02	(0.62–1.67)	0.953				2.74	(1.55–4.83)	<0.001			
Alcohol use at least monthly	1.19	(0.86–1.64)	0.307				1.21	(0.72–2.04)	0.473			
Insomnia (BNSQ ≥ 2)	1.98	(1.58–2.48)	<0.001	1.55	(1.18–2.04)	0.002	2.65	(1.82–3.87)	<0.001	2.23	(1.27–3.92)	0.005
Sleepiness (ESS ≥ 11)	1.92	(1.17–3.15)	0.010				2.38	(1.18–4.78)	0.015			
Pregnancy related health problems	1.51	(1.17–1.93)	0.001				1.58	(1.06–2.34)	0.025			
Somatic illness/disability	1.28	(0.99–1.67)	0.063				1.91	(1.29–2.82)	0.001			
Diagnosed depression, lifetime	2.69	(1.92–3.77)	<0.001	2.48	(1.66–3.70)	<0.001	7.73	(5.08–11.74)	<0.001	5.12	(2.78–9.44)	<0.001
Using antidepressants, past six months	1.89	(1.02–3.50)	0.044				3.47	(1.61–7.45)	0.001			
Anxiousness (STAI ≥ 12)	5.44	(3.72–7.96)	<0.001	3.66	(2.24–5.96)	<0.001	39.46	(24.97–62.38)	<0.001	10.75	(5.60–20.64)	<0.001
Stressfulness (PSS ≥ 10)	7.80	(4.59–13.25)	<0.001	3.29	(1.67–6.49)	0.001	65.61	(37.37–115.20)	<0.001	11.03	(5.02–24.22)	<0.001
Two or more distressing life events	1.87	(1.36–2.56)	<0.001				3.05	(1.97–4.70)	<0.001			
Poor family atmosphere	5.34	(3.47–8.22)	<0.001	5.26	(3.09–8.98)	<0.001	25.62	(15.85–41.42)	<0.001	14.34	(7.22–28.49)	<0.001

BNSQ = Basic Nordic Sleep Questionnaire (five items); ESS = Epworth Sleepiness Scale; STAI = State-Trait Anxiety Inventory (six items); PSS = Perceived Stress Scale (five items).

[a] Low depressive symptom trajectory (N = 1053) as a base category.

[b] Using backward stepwise selection method.

that warrants early (even pre-pregnancy) detection and appropriate treatment efforts (Stuart and Koleva, 2014; Patton et al., 2015; Sockol, 2018).

Among depressed fathers, some studies have found consistency in symptom duration, with the majority of prenatally depressed fathers remaining symptomatically depressed when assessed between four and 12 months postpartum (Matthey et al., 2000; Paulson et al., 2016). However, previous studies on depression trajectories among fathers are scarce. Our findings suggest that fathers' depressive symptom trajectories resemble those of mothers in the number and stability of trajectories, at least regarding those trajectories with low or moderate levels of symptoms. However, the high depressive symptom trajectory among fathers in our study seemed somewhat more time-varying, with an increase in symptoms between three and eight-month measurement points. This increase in symptoms during the first year postpartum is similar to that reported by Molgora et al. (2017) in their study among first-time fathers: in addition to stable low and stable moderate trajectories, the highest depressive symptom trajectory was named "emergent clinical depression" due to an increase in symptoms to a clinically significant level from six to 12 months postpartum. It has been suggested that compared to mothers, postpartum depression in fathers begins later after childbirth, developing more gradually with an

Table 4
Baseline predictors of paternal depressive symptom trajectories. Relative risk ratios (RRR) from multinomial logistic regression models.

	Moderate depressive symptom trajectory (N = 362)[a]						High depressive symptom trajectory (N = 41)[a]					
	Univariate			Multivariate[b]			Univariate			Multivariate[b]		
Predictor variable	RRR	(95% CI)	p	RRR	(95% CI)	p	RRR	(95% CI)	p	RRR	(95% CI)	p
Age	1.02	(0.99–1.04)	0.210				1.02	(0.96–1.09)	0.489			
Having previous child/children	0.92	(0.71–1.18)	0.501				1.27	(0.65–2.46)	0.482			
Education			0.536						0.019			
None or some vocational training	1.00						1.00					
Vocational degree or polytechnic	0.82	(0.56–1.20)	0.302				0.46	(0.21–1.01)	0.054			
University	0.80	(0.53–1.21)	0.286				0.23	(0.08–0.65)	0.006			
Low personal net income	2.12	(1.37–3.26)	0.001				6.31	(2.94–13.54)	<0.001			
Smoking currently	1.03	(0.76–1.41)	0.833				2.83	(1.46–5.46)	0.002			
Alcohol use at least two times a week	1.13	(0.87–1.47)	0.349				1.38	(0.71–2.67)	0.343			
Insomnia (BNSQ ≥ 2)	3.55	(2.50–5.04)	<0.001	4.01	(2.47–6.51)	<0.001	9.40	(4.79–18.45)	<0.001	6.94	(2.60–18.50)	<0.001
Sleepiness (ESS ≥ 11)	2.46	(1.48–4.10)	0.001				2.41	(0.71–8.17)	0.157			
Somatic illness/disability	1.74	(1.28–2.35)	<0.001				3.68	(1.90–7.13)	<0.001			
Diagnosed depression, lifetime	4.41	(2.74–7.11)	<0.001	2.34	(1.18–4.62)	0.015	37.11	(18.08–76.19)	<0.001	10.76	(3.82–30.30)	<0.001
Using antidepressants, past six months	2.30	(1.35–3.91)	0.002				14.50	(6.78–31.01)	<0.001			
Anxiousness (STAI ≥ 12)	12.93	(8.68–19.27)	<0.001	8.82	(4.98–15.64)	<0.001	80.52	(37.38–173.45)	<0.001	20.45	(7.13–58.69)	<0.001
Stressfulness (PSS ≥ 10)	11.99	(7.41–19.39)	<0.001	5.66	(2.76–11.65)	<0.001	71.44	(33.72–151.34)	<0.001	15.29	(5.01–46.65)	<0.001
Two or more distressing life events	3.24	(2.31–4.55)	<0.001	2.06	(1.24–3.44)	0.006	7.72	(3.91–15.25)	<0.001	2.07	(0.73–5.90)	0.171
Poor family atmosphere	4.28	(3.00–6.12)	<0.001	2.84	(1.68–4.79)	<0.001	21.03	(10.66–41.49)	<0.001	10.20	(3.93–26.46)	<0.001

BNSQ = Basic Nordic Sleep Questionnaire (five items); ESS = Epworth Sleepiness Scale; STAI = State-Trait Anxiety Inventory (six items); PSS = Perceived Stress Scale (five items).

[a] Low depressive symptom trajectory (N = 1201) as a base category.

[b] Using backward stepwise selection method.

Table 5
Association between maternal and paternal depressive symptom trajectory groups.

Paternal depressive symptom trajectory	Maternal depressive symptom trajectory							
	Low		Moderate		High		Total	
Low	833 82.1%	69.4%	302 66.4%	25.2%	65 48.9%	5.4%	1200 74.9%	100%
Moderate	171 16.8%	47.2%	135 29.7%	37.3%	56 42.1%	15.5%	362 22.6%	100%
High	11 1.1%	26.8%	18 4.0%	43.9%	12 9.0%	29.3%	41 2.6%	100%
Total	1015 100%	63.3%	455 100%	28.4%	133 100%	8.3%	1603 100%	100%

increasing rate over the first year (Kim and Swain, 2007). It might be that in men, predictors of postpartum depression are more linked to current social and relational situation (Bielawska-Batorowicz and Kossakowska-Petrycka, 2006), which is in a process of constant change for new parents—perhaps even more so for the fathers in our contemporary society, where men are struggling to combine traditional and more modern roles of fatherhood (Crespi and Ruspini, 2015). Perhaps the challenges to combine work and family commitments have increased depressive symptoms among the high symptom profile fathers, already at high level of symptoms, and thus more vulnerable to these stressors, especially around the end of the first year after a child birth, when many mothers are returning to work. Also in our study, the percentage of fathers above the suggested cut-off for clinically significant depressive symptoms doubled from prenatal (or three months) to two years postpartum. This finding, however, is somewhat different from the results by Paulson and Bazemore (2010) reporting in their meta-analysis the highest incidence rate of postpartum depression among fathers to be between three and six months postpartum, thus resembling more the incidence patterns observed among mothers.

The strongest prenatal risk factors for mothers' and fathers' higher depressive symptom trajectories were related to current or earlier psychopathology (depression and anxiousness), stressfulness, insomnia, and poor family atmosphere. These are all well in line with the earlier literature (Robertson et al., 2004; Lancaster et al., 2010; Wee et al., 2011; Lawson et al., 2015). For example, depression or anxiety during pregnancy, previous history of depressive illness, recently experienced stressful life events, and low levels of social support were the strongest predictors of mothers' postpartum depression reported by Robertson et al. (2004) in their synthesis of the literature. That prenatal and previous psychopathology are among the strongest predictors of perinatal depression again highlights the importance in clinical work of obtaining a thorough clinical history, screening for concurrent symptoms, and offering appropriate treatments. Further, the stability of trajectories suggests continuation of symptoms that may have been present already in the pre-pregnancy period, as has been suggested earlier (Patton et al., 2015). In our study, insomnia and (to a lesser extent) sleepiness during pregnancy predicted depression trajectories, suggesting sleep problems as possible candidates for a closer screening and treatment at maternity clinics to prevent postpartum depression (Lawson et al., 2015; Pietikäinen et al., 2018).

The majority of the studied correlates were significant at least in some analyses, while their relative importance diminished in multivariate analyses. For example, socioeconomic status (low income and education) and among mothers pregnancy-related health issues were no longer significant predictors of the depressive symptom trajectories in multivariate analyses. Of the studied prenatal factors, alcohol use was the only factor that had no significant associations with the depressive symptom trajectories in any of the analyses.

Remarkably, in our study the strongest risk factors for depressive symptom trajectories were common to both father and mother. While some studies have suggested that the risk factors could be different for fathers, i.e. relating more to situational factors and not to an individual's characteristics (Bielawska-Batorowicz and Kossakowska-Petrycka, 2006), our results point to similarities rather than differences between parents in risk factors for perinatal depressive symptoms (Matthey et al., 2000; Davé et al., 2010). These similarities in our study might be due to the relatively strong effects, i.e. these factors are so strongly associated with depression, that differences between genders remain subsidiary. Despite the similarities, there were some apparent differences in the effects too. For example, the risk factor of prenatal distressing life events was significant in the multivariate model among fathers only—a finding in line with previous research (Leung et al., 2017). On the other hand, the effects of poor family atmosphere on depressive symptom trajectories seemed somewhat stronger among mothers. In line with previous research suggesting marital dissatisfaction (a concept closely related to family atmosphere) to be a risk factor for perinatal depressive symptoms among both mothers and fathers (e.g. Letourneau et al., 2012), our results suggest that during pregnancy this effect might be stronger for the mother.

Maternal and paternal depressive symptom trajectories were also significantly correlated. That the one parent's depression is a strong predictor of the other parent's depression is also congruent with previous research findings (Paulson and Bazemore, 2010; Wee et al., 2011). One probable mechanism between depressive symptoms from one parent to the other is marital dissatisfaction (Lancaster et al., 2010; Wee et al., 2011; Letourneau et al., 2012). In line with this, poor family atmosphere was one of the strongest predictors of depressive symptom trajectories in our study, and this was the case among both mothers and fathers. Poor family atmosphere and marital problems in turn could stem from heightened life stress, which is common among expecting and new parents. Altogether, these findings suggest that the whole family, including fathers, needs to be considered in perinatal care; and further, that depression or depressive symptoms in one parent should prompt clinical attention to the other parent (Paulson and Bazemore, 2010; Letourneau et al., 2012).

8. Limitations

Some limitations of our study should be noted. First, there was a non-negligible amount of sample attrition, especially among fathers. Missing information due to attrition was handled by using FIML estimation method in Mplus software. These types of estimation methods are preferable to conventional methods of dealing with missing information (Allison, 2003). For example, in our study a listwise deletion of cases would have produced biased (too low) CES-D score means among mothers (see Supplement Fig. 1). In addition, we also ran sensitivity analyses for the latent profile solutions using only cases for whom there were at least three (out of four) CES-D measurements available. The latent profiles/trajectories and statistical criteria for the solutions remained essentially the same compared to those presented using all cases (i.e. allowing a minimum of one available measurement per case). Second, the number of cases in the high depression trajectory group among fathers was rather low, perhaps making this group not fully comparable to the high trajectory group of mothers. When comparing the relative proportions of our three trajectory groups to those found in other studies, two studies among mothers comparable to our study (i.e. population based sample; data from pregnancy to at least 12 months postpartum; using latent class/profile analysis) and reporting three relatively stable groups, reported groups and their relative proportions very similar to ours (Barker, 2013; Giallo et al., 2015). Among fathers comparable studies are difficult find: Molgora et al. (2017) reported three groups of fathers, with a more prevalent "high" trajectory group (11%) compared to ours (2.6%). However, these differences could be due to differences in samples and used methods. Third, the

latent profiles of depressive symptoms are to be treated as being suggestive in their nature of "real entities"—simply undertaking an LPA and deciding on a best-fitting solution is not sufficient to prove that the profiles actually exist as tangible groups in the population. Moreover, while a high trajectory was reported (using CES-D as a continuous measure) among mothers and fathers, this doesn't necessarily mean that members of these groups were suffering from chronic depression throughout the perinatal period. Although our study design is prospective, and in the analyses we treat prenatal factors as predictors of depressive symptom trajectories, the direction of effects between variables or causality cannot be determined based on our analyses. We used a community sample, which has been indicated to be relatively representative of the target population (Paavonen et al., 2017), with the exceptions that those with lower education and single mothers were underrepresented in the sample. This warrants caution when generalizing our results to other populations.

9. Conclusions

Parental depressive symptom trajectories from pregnancy up to two years postpartum seem stable, indicating the chronic nature of perinatal or postpartum depression. Mothers' and fathers' symptom trajectories are associated with each other, and their strongest predictors are common for both. Our findings underline the importance of inquiring about both the mothers' and fathers' depressive symptoms already during pregnancy. Given the chronicity of symptoms suggested by the trajectories, their treatment should begin as soon as the elevated symptom levels are observed. In addition to perinatal depressive disorders, evidence based treatment modalities should be tailored to cover moderate subclinical levels of depressive symptoms. Prompt and appropriate treatment of perinatal depression would alleviate a lot of suffering of the expecting and new parents and their offspring.

CRediT authorship contribution statement

Olli Kiviruusu: Formal analysis, Writing - original draft, Writing - review & editing. **Johanna T. Pietikäinen:** Funding acquisition, Writing - original draft, Writing - review & editing. **Anneli Kylliäinen:** Conceptualization, Methodology, Project administration, Funding acquisition, Writing - review & editing. **Pirjo Pölkki:** Conceptualization, Methodology, Project administration, Writing - review & editing. **Outi Saarenpää-Heikkilä:** Conceptualization, Methodology, Project administration, Funding acquisition, Writing - review & editing. **Mauri Marttunen:** Funding acquisition, Writing - review & editing. **Tiina Paunio:** Conceptualization, Methodology, Project administration, Funding acquisition, Writing - review & editing. **E. Juulia Paavonen:** Conceptualization, Methodology, Project administration, Funding acquisition, Writing - review & editing.

Declaration of Competing Interest

The authors declare no conflict of interest.

Funding

This work was supported by the Academy of Finland (# 134880 and 253346 TP; # 308588 EJP, # 277557 OSH, # 309117 MM, # 317080 AK), Foundation for Pediatric Research (EJP, JTP), Competitive Research Financing of the Expert Responsibility area of Helsinki University Hospital (JTP), Emil Aaltonen Foundation (JTP), Finnish Psychiatric Association (JTP), Gyllenberg Foundation (TP), Yrjö Jahnsson Foundation (EJP), Finnish Cultural Foundation (EJP), Competitive Research Financing of the Expert Responsibility area of Tampere University Hospital (OSH), Arvo and Lea Ylppö Foundation (OSH) and Doctors' Association in Tampere (OSH) .

Acknowledgment

None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2019.09.038.

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